Welcome to the *Climate-Safe Infrastructure* Webinar Series

Supporting AB2800 and the Work of California's Climate-Safe Infrastructure Working Group

June 11, 2018 | 12-1pm

CALIFORNIA natural resources AGENCY

Hosts

Juliette Finzi Hart | USGS

Co-Facilitator of CSIWG's work

Email: jfinzihart@usgs.gov

Susi Moser | Susanne Moser Research & Consulting

Co-Facilitator of CSIWG's work

Email: promundi@susannemoser.com

AB 2800 (Quirk): Purpose

Examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering, including oversight, investment, design, and construction.

AB2800 Working Group and Support Team

Co-Facilitators

Juliette Finzi Hart
USGS

Susi Moser
Susanne Moser
Research & Consulting

The Climate-Safe Infrastructure Working Group

Amir Aghakouchak
UC-Irvine

Bruce Swanger
Cal-Trans

Chester Widom
DGS, State Architect

Cis Liban
L.A. Metro

Dan Cayan
UC-San Diego, SIO

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DGS, Off. of Sustain.

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High-Speed Rail Auth.

John Andrew
DWR

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Realized Energy

Kyle Meng
UC-Santa Barbara

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CEC

Noah Diffenbaugh
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Robert Lempert
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Project Team

Keali'i Bright
Natural Resources
Agency

Elea Becker Lowe
Natural Resources
Agency

Joey Wall
Natural Resources
Agency

Guido Franco
California Energy
Commission

AB 2800 (Quirk): Scope of Assessment and Recommendations

The working group shall consider and investigate, at a minimum, the following issues:

(1) **informational and institutional barriers** to integrating climate change into infrastructure design.

(2) **critical information needs** of engineers.

(3) **selection of appropriate engineering designs** for different climate scenarios.

The *Climate-Safe Infrastructure* Webinar Series

Purpose

- Hear from others elsewhere with relevant experience and expertise.
- Hear from CSIWG members.
- Educate and engage with interested stakeholders on climate change and infrastructure issues.

Sample of Webinar Topics

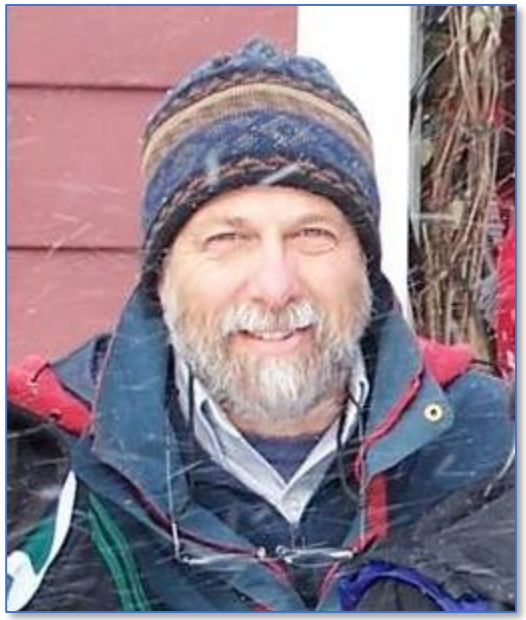
- What climate science can offer
- Various sectoral perspectives
- Processes of changing engineering standards and guidelines
- Holistic infrastructure planning and management
- Financing climate-safe infrastructure
- And others…

A Couple of Housekeeping Items

- Please type your questions for presenters into the chat box
- We will try to answer as many as possible after the presentations
- Answers to remaining questions will be posted on the website
- Thank you to USC Sea Grant!

Monitoring Infrastructure Performance

Jennifer Jurado, Ph.D.
Chief Resilience Officer
Division Director
Broward County



Peter Murdoch, Ph.D.
Regional Science Advisor
USGS

Andreas Georgoulias, Ph.D.
Research Director
Zofnass Program for Sustainable Infrastructure

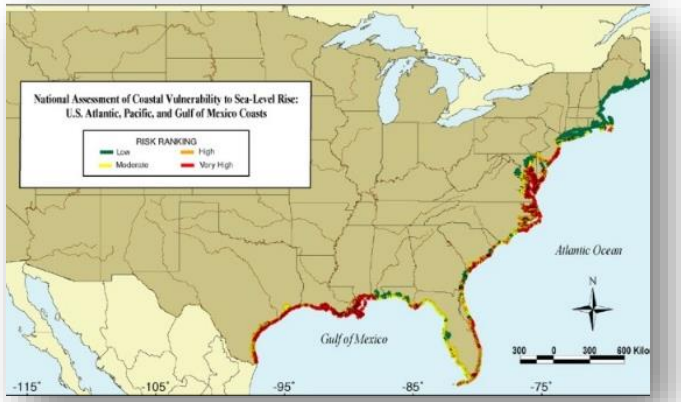
Banking on Resilience: Advancements and Lessons from Southeast Florida

California Climate-Safe Infrastructure Webinar
June 11, 2018

Dr. Jennifer L. Jurado, CRO and Director
Environmental Planning and Community Resilience Division

BROWARD COUNTY FLORIDA

The Region of Southeast Florida



Characterized by:

- ❑Dense coastal development
- ❑Flat, low-lying terrain
- ❑Active flood management
- ❑Complex system of canals and structures

Noted vulnerabilities:

- ❑Nearly 6 million residents
- ❑Substantially altered land use
- ❑Rising seas
- ❑More intense storms and rainfall

Compounding current flood conditions and future flood risk

Abundant Flood Risk and Infrastructure Needs

2018 Monroe County – Hurricane Irma

WEATHER

Sawgrass Mills mall closed for third day because of flooding

Sunrise outlet mall to reopen Saturday

By Peter Burke - Local10.com Managing Editor

This car was left abandoned after the water overtook it in the parking lot of the Sawgrass Mills mall.

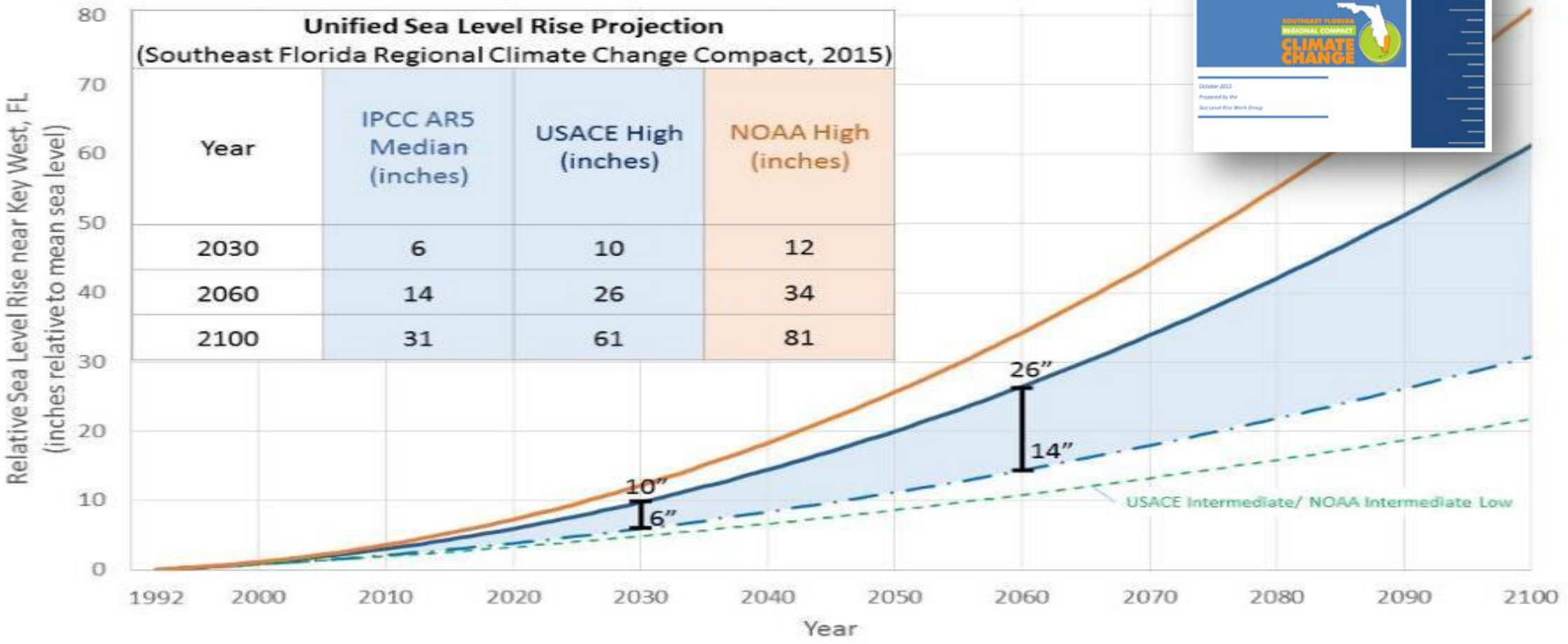
2016 Fort Lauderdale - Tidal Flooding

2015 Palm Beach – 22” rainfall

Regional SLR Projection

Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

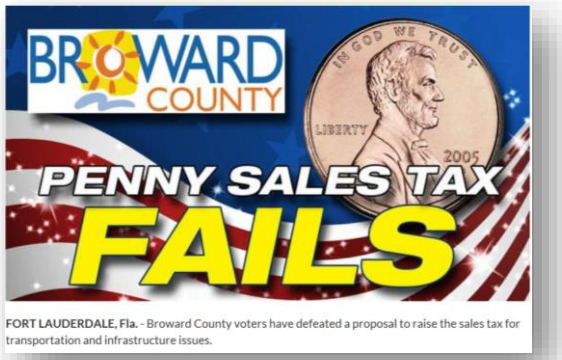


Yet, in 2016 infrastructure tax failed

What Are The Broward Half-Cent Sales Taxes? For Some Voters, An Issue of Public Trust

By KATE STEIN • OCT 19, 2016

Reject Broward sales tax, plan is a boondoggle | Editorial



Broward County Voters Approve One Sales Tax Measure but Reject Another; Neither Passes

Had it not been for the political compromise that enabled it to be placed on the ballot, voters would have narrowly passed a county transportation sales tax measure. In neighboring Palm Beach County, a straight-forward sales tax measure passed.

November 28, 2016, 1pm PST | Irvin Dawid

Community Issues

- ❑ SLR and Flooding
- ❑ Boil water notices
- ❑ Aging water infrastructure

Yet, 30-yr proposal provides

- ❑ 27% for parks
- ❑ 17% for government buildings
- ❑ 10% for vehicles
- ❑ Only 9% for water infrastructure

(and cities continue to divert funds from utilities)

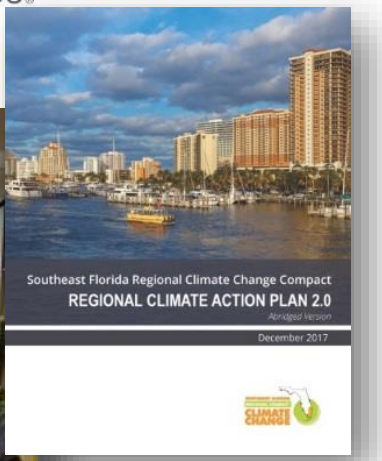
Restructuring Conversation and Relationship

2016

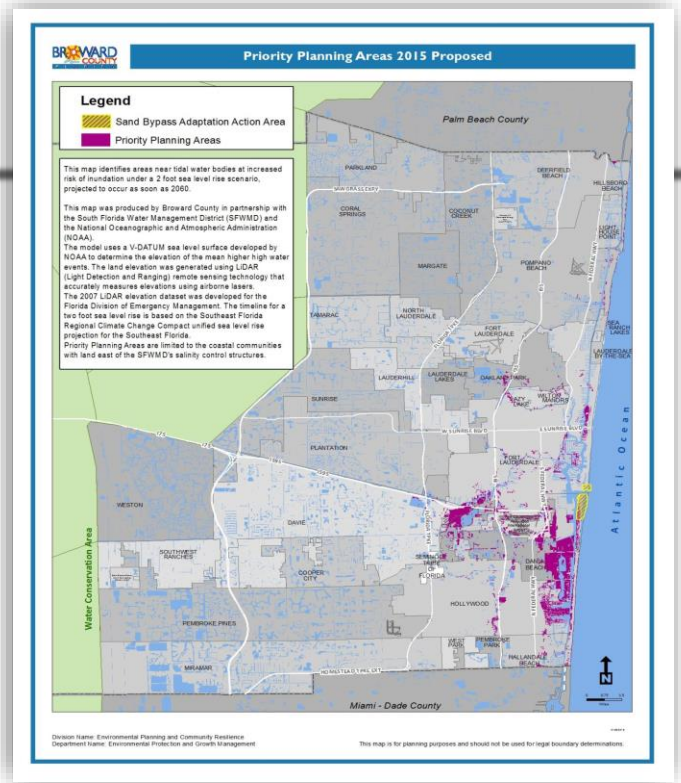
- Regional economics workshop
  - Finance
  - Insurance
  - Risk management
- Sea level rise forum

2017

- Business resilience committees
- Economic resilience in regional action plan
- Summit theme “Business of Resilience
- Statement of collaboration



Resilience as a Process



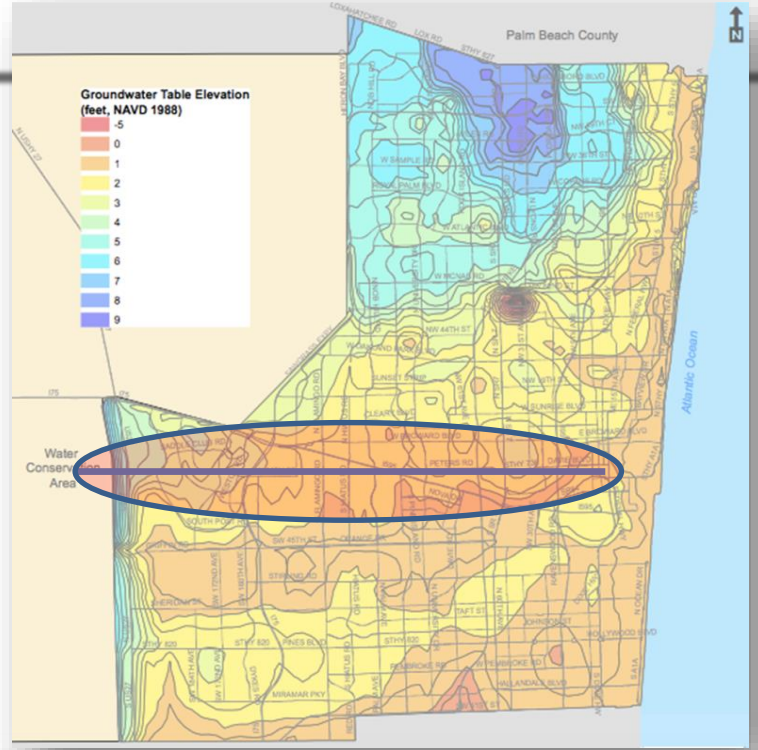
Process and Strategy

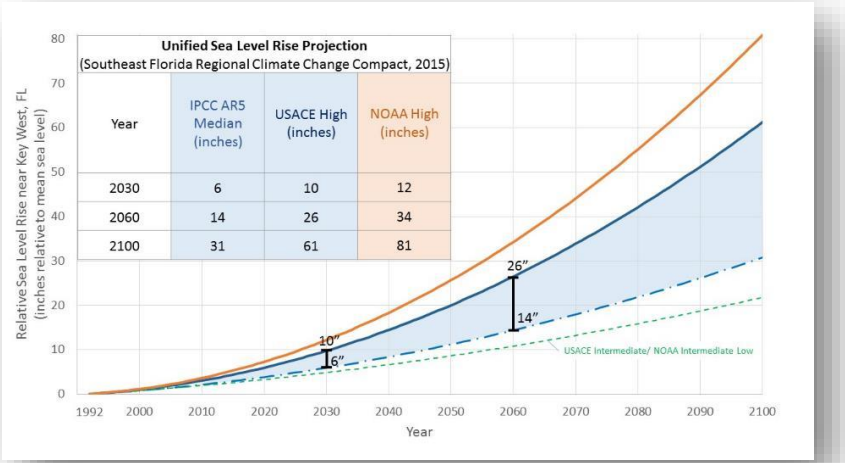
- ❑ Land Use
  - Priority Planning Areas
  - Adaptation Action Areas
  - Comp Plan/Land Use

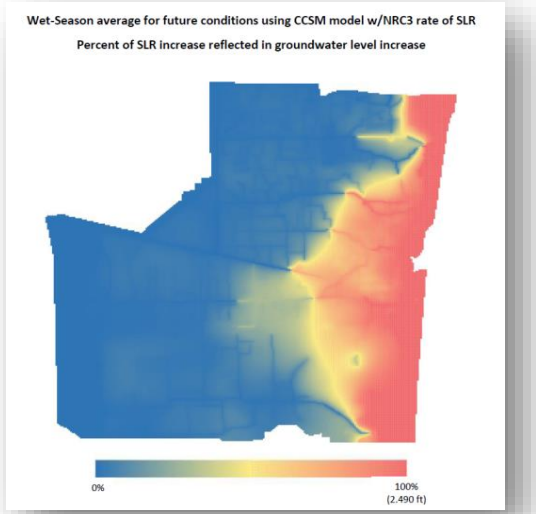
- ❑ Site specific planning and design
- ❑ Regional systems and infrastructure
- ❑ Timeline
  - Drainage infrastructure (2017)
  - Coastal flood barriers (2018)
  - Flood elevations (2019)
  - Infrastructure plan (2020)

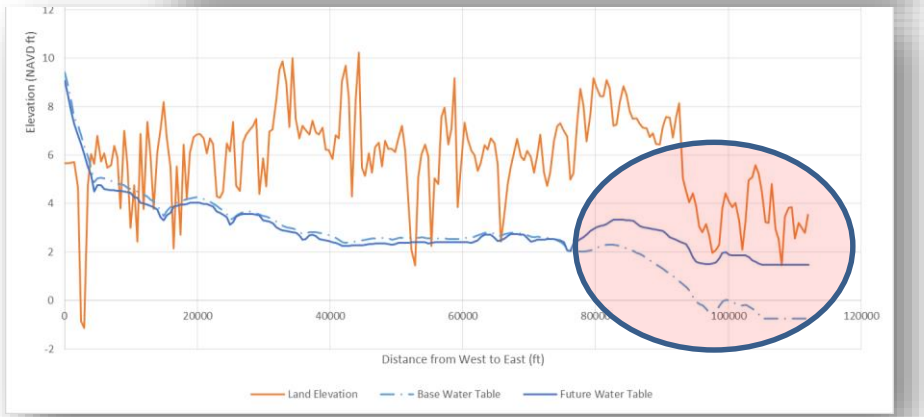
Future Condition Average Wet Season Groundwater Table Map

- 2060-2069 average groundwater conditions
- USACE high = 2 feet SLR
- CCSM model = 9% increase in rainfall
- Stakeholder engagement
- Effective July 1, 2017







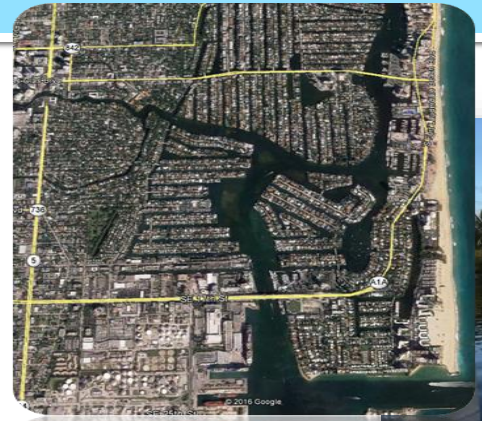


USACE-Broward Resiliency Study

US Army Corps of Engineers®

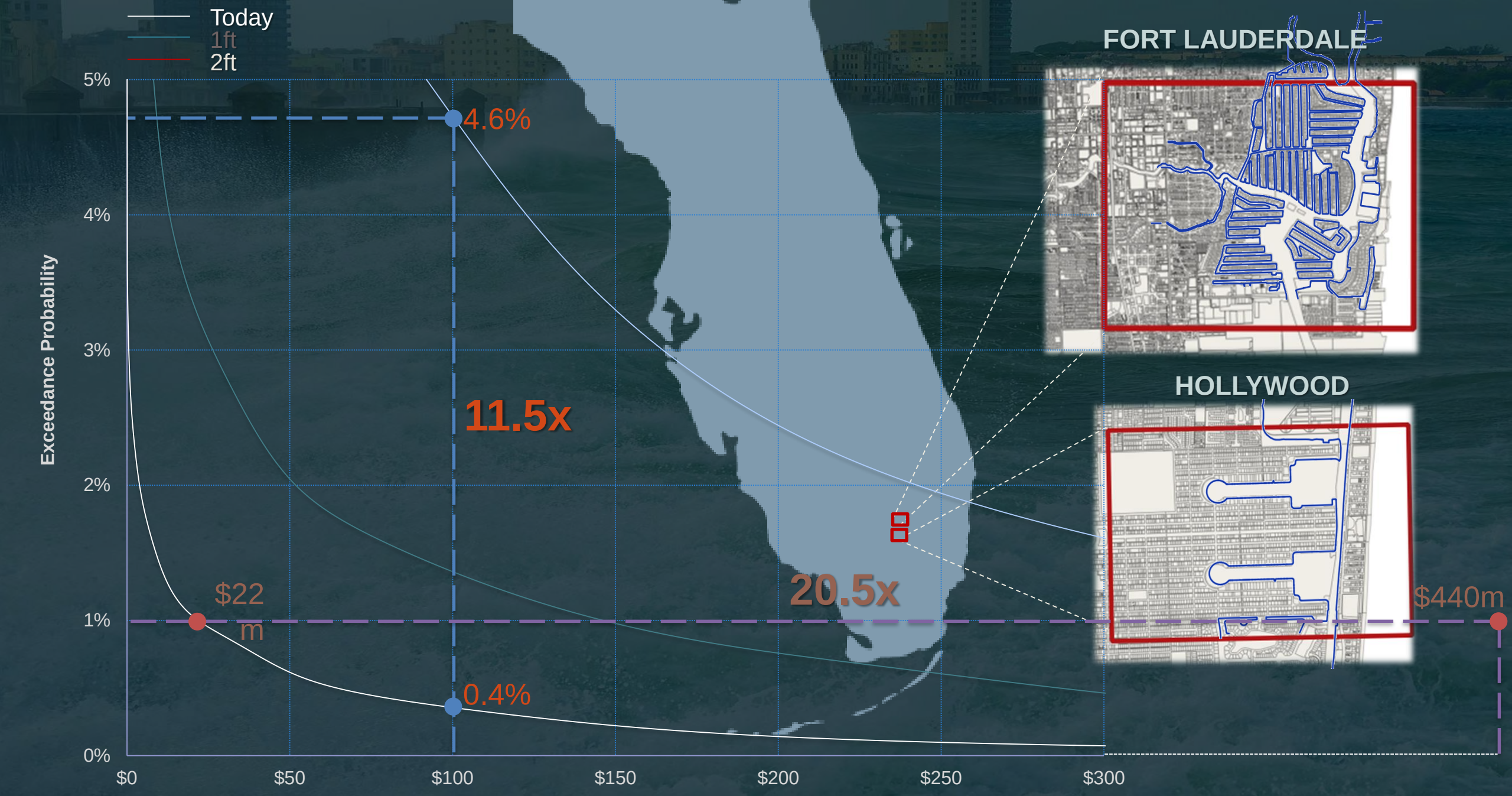
RMS

- Resilient Sea Wall Top Elevations
- Calibrated hydrodynamic model
  - 2 feet sea level rise
  - High tides
  - 25-yr storm surge
- Economic study
  - Damage loss reduction
  - Commercial activity



CITY OF FORT LAUDERDALE

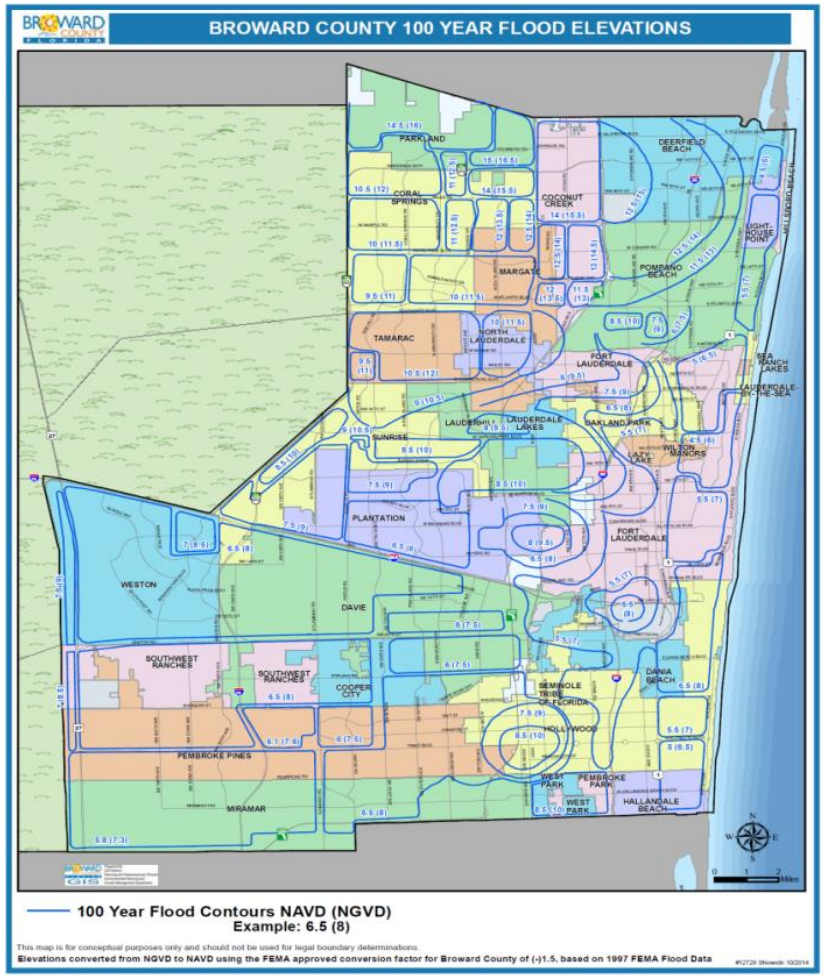
CITY OF HOLLYWOOD, FLORIDA
DIAMOND OF THE GOLD COAST
INCORPORATED 1925



Update to Broward 100-Year Flood Map

- One of 3 tools used to set finished floor elevations
- Historically - worst case condition
- Does not account for sea level rise

- Amended map will:
  - Integrate sea level rise
  - Capture changes in groundwater
  - Provide flood elevation with rainfall
  - Address CRS creditable criteria
  - Reduce flood risk/higher standards
  - NOT be used to set FEMA FIRMS



Reinforcing the Need for a Range of Investments

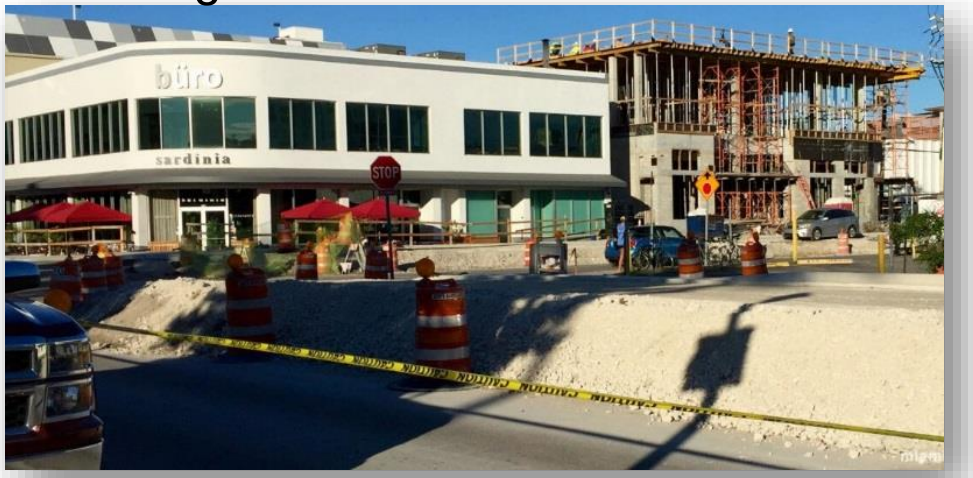
Raise Sea Walls

Stormwater Improvements

Increased Free Board

Regional Water Storage

Elevating Roads and Critical Infrastructure



Active Management

Economic Basis for Action

- Protect infrastructure
- Reduce flood risk and losses
- Protect credit ratings
- Improve insurance affordability
- Protect property values/tax base

MOODY'S INVESTORS SERVICE

Bloomberg

BUSINESS INSIDER

Collaborating on Economic Resilience

SFRPC
South Florida Regional Planning Council
Proudly serving South Florida since 1974

CHAMBER of COMMERCE
OF THE PALM BEACHES

GREATER FORT LAUDERDALE
CHAMBER OF COMMERCE

The Beacon Council

GREATER
HOLLYWOOD
CHAMBER OF COMMERCE

TREASURE COAST
TCRPC
REGIONAL PLANNING COUNCIL
"Preserving One Neighborhood At A Time" - Est. 1976

greater miami chamber of commerce

Sun-Sentinel

WLRN
Miami | South Florida

PalmBeachPost

The Miami Herald

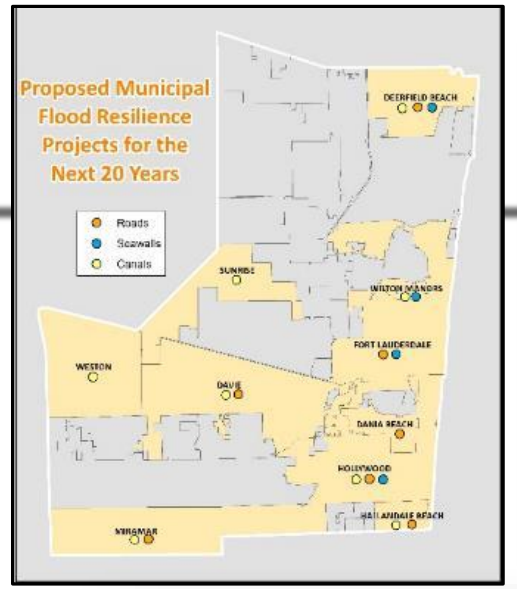
THE INVADING SEA

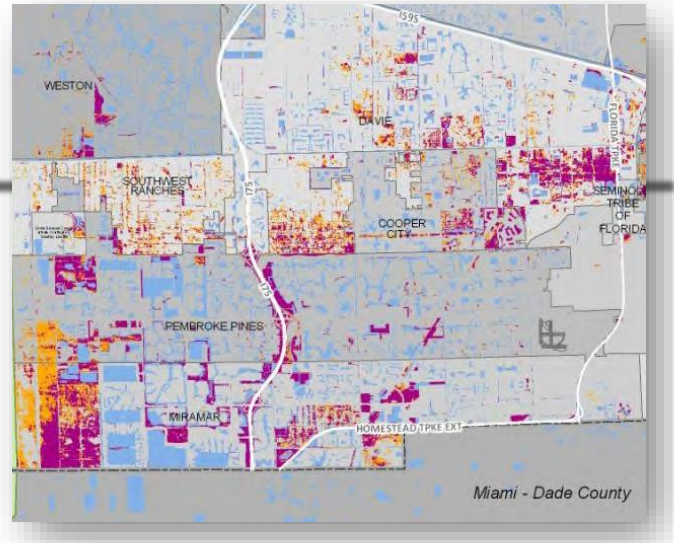
greater fort lauderdale alliance | broward county
Life. Less taxing.

BROWARD WORKSHOP

Organized Action

- 2018 Resilience Roundtable
- Elected and business leadership
- Action Items:
  - ✓Perform regional risk assessment
  - ✓Identify priority capital improvements
  - ✓Develop a coordinated, resilient infrastructure investment plan
  - ✓Include economics
  - ✓Communicate





Broward Leaders Resilience Roundtable
5/24/2018

#ResilientTogether

Summary

- Flooding is the most pressing resiliency challenge for SE Florida, and probably for much of our state
- Risk reduction requires a tiered approach addressing future conditions, standards, site specific improvements, and systems
- Near-term economic consequences provide expanded basis for strategic and coordinated action
- Regionally-scaled investment will require a formal plan, with measures and ROI
- Consistency, transparency, and communications remain key

Questions?

Dr. Jennifer L. Jurado
Chief Resilience Officer, Director
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Broward County
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Intermission: Reasons to think about tracking adaptation success

1. **Communication and public engagement**
   - Communicating hope and desirable goal to work towards
   - Defining a common vision among diverse stakeholders
2. **Deliberate planning and decision-making**
   - Setting clear goals, aligning means and ends (internal consistency)
   - Best fit with other policy goals (external consistency)
3. **Justification of adaptation expenditures**
4. **Accountability/good governance**
5. **Support for learning and adaptive management**

Measuring resilience change for management best practices: the DOI Sandy projects

Peter S. Murdoch, Susan M. Taylor, Richard O. Bennett, Kimberley Penn, Bhaskar Subramanian

California Climate-Safe Infrastructure Working Group
Sacramento, CA
June 11, 2018

The DOI Hurricane Sandy Program

- Hurricane Sandy made landfall in the Northeastern US on Oct. 29, 2012, wreaking havoc on communities in 12 states and the District of Columbia
- Through disaster relief funding, DOI funded over 160 projects (about $340 million) for projects aimed at understanding and improving ***resilience***

DOI Sandy Response Resilience Projects

Projects designed to provide ecosystem and community resilience to flooding, storm surge, SLR and increased storm events

- **Marsh Restoration**
- **Beach Restoration**
- **Aquatic Connectivity**
- **Science Support Tools**

http://www.fws.gov/hurricane/sandy/

Charge from the 2013 Federal Disaster Recovery Coordination Workplan:

"Quantifying benefits of resilience projects and calculating resilience project return on investment in order to better inform future public spending"

The DOI Challenge

By 2022, DOI needs to assess the success of 165 projects in enhancing resilience. ***<u>This requires:</u>***

- ***Rapid detection of resilience change*** (Sandy supplemental funding allowed 3 years of study- we extended metrics to 2022)
- ***Core measurements*** that have ***some existing record*** and can allow for cross-project comparison and trend detection
- ***Baseline conditions and vulnerability (tipping points) for detecting change*** (often poorly documented)
- ***Linkage between social and ecosystem resilience for whole-system management,*** but each measured with existing, robust methods

The DOI Strategy

- ✓ Catalog outcomes expected from across the 165 projects
- ✓ Select core metrics of socio-economic and environmental change (convened experts)
- ✓ Study factors determining vulnerability (condition and tipping points) in projects
- ✓ Expand data sources by agreements on core metrics across agencies
- ✓ *Make data and interpretations easily accessible to stakeholders and investigators*
- *Measure baseline and post-project conditions using tested, existing measurements*
- *Adopt an analysis framework for linking environmental and socio-economic change across time and space (trends and maps)*
- *Analyze resilience change by coastal feature, ecosystem service, and/or coastal sub-regions*
- *Translate into best management planning and practices*

Source: Stevens Institute of Technology, P. Orton and others
HDR, Inc., J. Fitzpatrick

Strategy for measuring change

DOI Metrics Expert Group

Sorting change metrics by coastal feature:

- Beaches, Dunes, and Breaches
- Wetlands, marshes, and ponds
- Nearshore waters and estuaries
- Built environments (Green, Grey, and Hybrid Infrastructure)
- Rivers and streams (dam removal)
- Upland watersheds and coastal forests

Abiotic: *position, shape, slope, elevation, sediment transport, contaminants*

Biotic: *Vegetation (e.g., % invasive, species diversity, % cover)*
Birds and Fish population demographics (e.g., recruitment, abundance, condition, species diversity),

https://www.doi.gov/sites/doi.gov/files/migrated/news/upload/Hurricane-Sandy-project-metrics-report.pdf

Natural Infrastructure Metrics (NIMs) Goals:

Develop core metrics that cut across agency missions, supporting efficiencies and knowledge base that demonstrate that natural infrastructure is:

- **Effective**
- **Resilient**
- **Cost Effective**
- **Focus on Ecosystem Services**
- **Report due soon**

NMs Metrics by Ecosystem Services

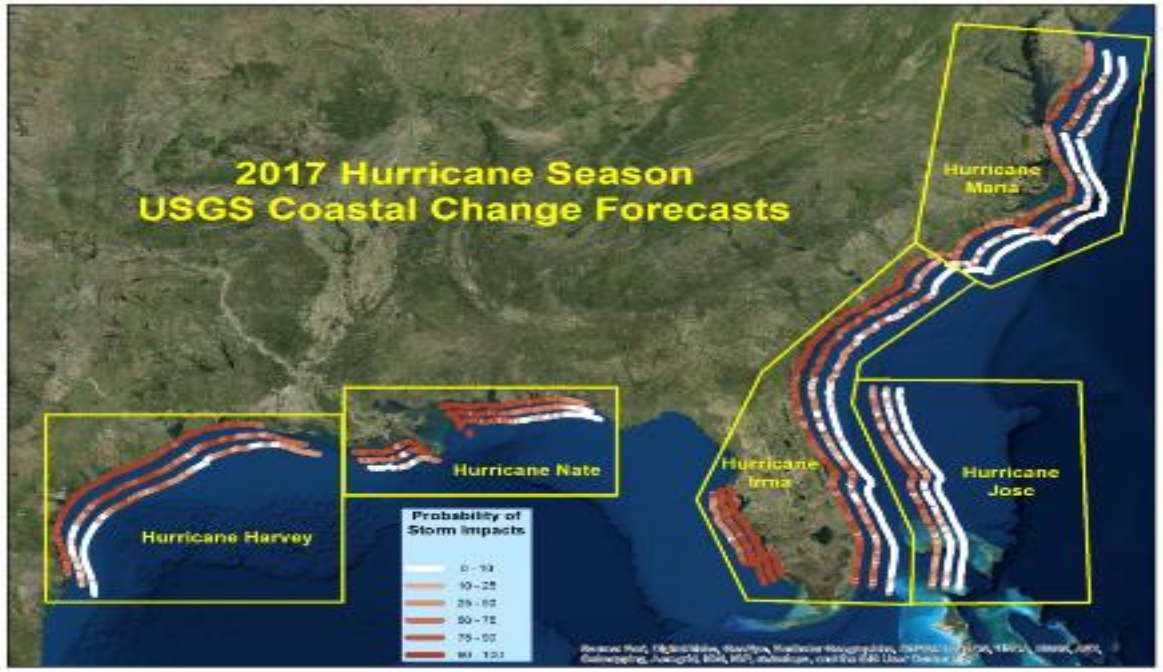
II. **REGULATING SERVICES**		
3	Reduce Flooding	○ Peak and wave height and period ○ Inundation extent, frequency, duration
4	Manage Erosion and Sedimentation	○ Turbidity (TSS) ○ Sediment movement ○ Change in shoreline position ○ Change in shoreline profile/elevation ○ Vegetation density
5	Reduce Velocity and Energy of Waves/Currents	○ Wave magnitude (height, velocity) ○ Wave run-up
6	Provide and Store Groundwater	○ Water table levels ○ Salinity of groundwater ○ Contaminant concentrations ○ Soil infiltration rate
7	Improve Water Quality	○ Turbidity (TSS) ○ Biological ○ Pollutant concentrations (pathogens) ○ Contaminant concentrations
8	Provide Carbon and GHG Storage	○ Organic matter/ labile pool ○ Decomposition rate ○ Sediment oxidation
9	Reduce Wildfire Potential	○ Historical burn rate ○ Occurrence, intensity, size and space of fire
10	Provide Functional Surface Water Hydrology	○ Surface runoff

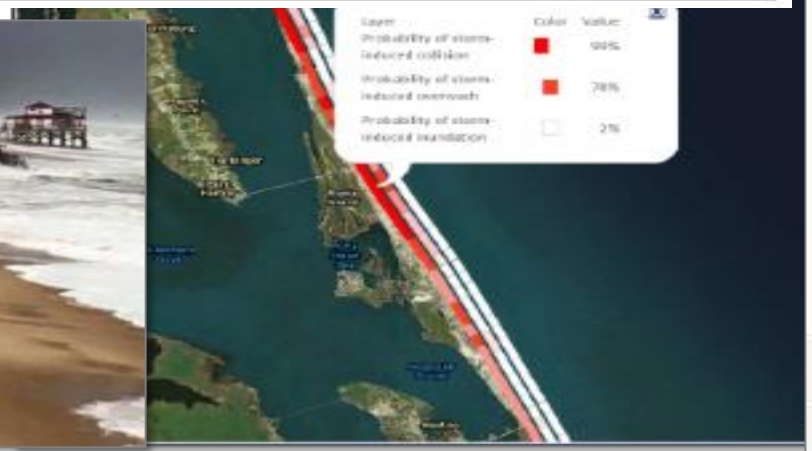

Beach erosion and damage Post-Sandy, NJ

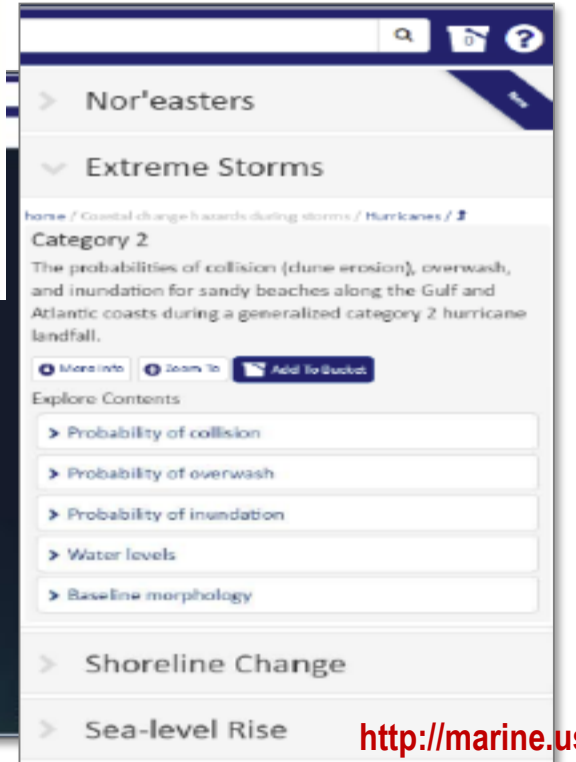

Parker River NWR, MA


Community Flooding, Chesapeake, VA
Photo: City of Chesapeake

Baseline Data to Resilience Response: e.g. LiDAR for Forecasting Erosion and SLR







Baseline Data
Pre-Post-Sandy elevation data and magnitudes of beach volume change

Improve Models
Update and improve accuracy of pre-landfall erosion forecasts (projects)

Vulnerability
Social, economic & infrastructure elements added to forecasts (projects)

Assess & Disseminate
Support best practice and share data through Coastal Change Hazards Portal

Requirement: Pre-storm, PROCESSED, LiDAR data

http://marine.usgs.gov/coasalchangehazardsportal/

An Earth System Framework

*The **"planetary boundaries"** doughnut concept (Rockstrom et al, 2009) and it's environmental justice corollary **"social foundations"** (Raworth, 2012) provides a framework for rigorous measurement of environmental and social factors affecting resilience*

Cost-effective measurements integrated to track whole systems

Final Thoughts

"If resilience is built through a project, and no resilience metric is around to measure it, does it have an impact?"

Anonymous, National Adaptation Forum, St. Louis, MO 2015

Measurement is a fraction of the cost of restoration or mitigation, and saves money over time by defining best practices for a changing world

Thank you!

- Questions: pmurdoch@usgs.gov
- DOI Sandy Program: https://www.doi.gov/hurricanesandy
- NFWF Sandy Program: http://www.nfwf.org/hurricanesandy/Pages/home.aspx

Commercial Incentives for Sustainable Infrastructure:

The case of the Governor George Deukmejian Courthouse in Long Beach, California

Dr. Andreas Georgoulias
Zofnass Program for Sustainable Infrastructure

Introduction

- **Scope of Study**
- **The Project**
- **Findings & lessons learned**
- **Conclusion**

Scope of Study

I. **Investigate** the feasibility of P3 in delivering long-term sustainability with respect to public sector buildings.

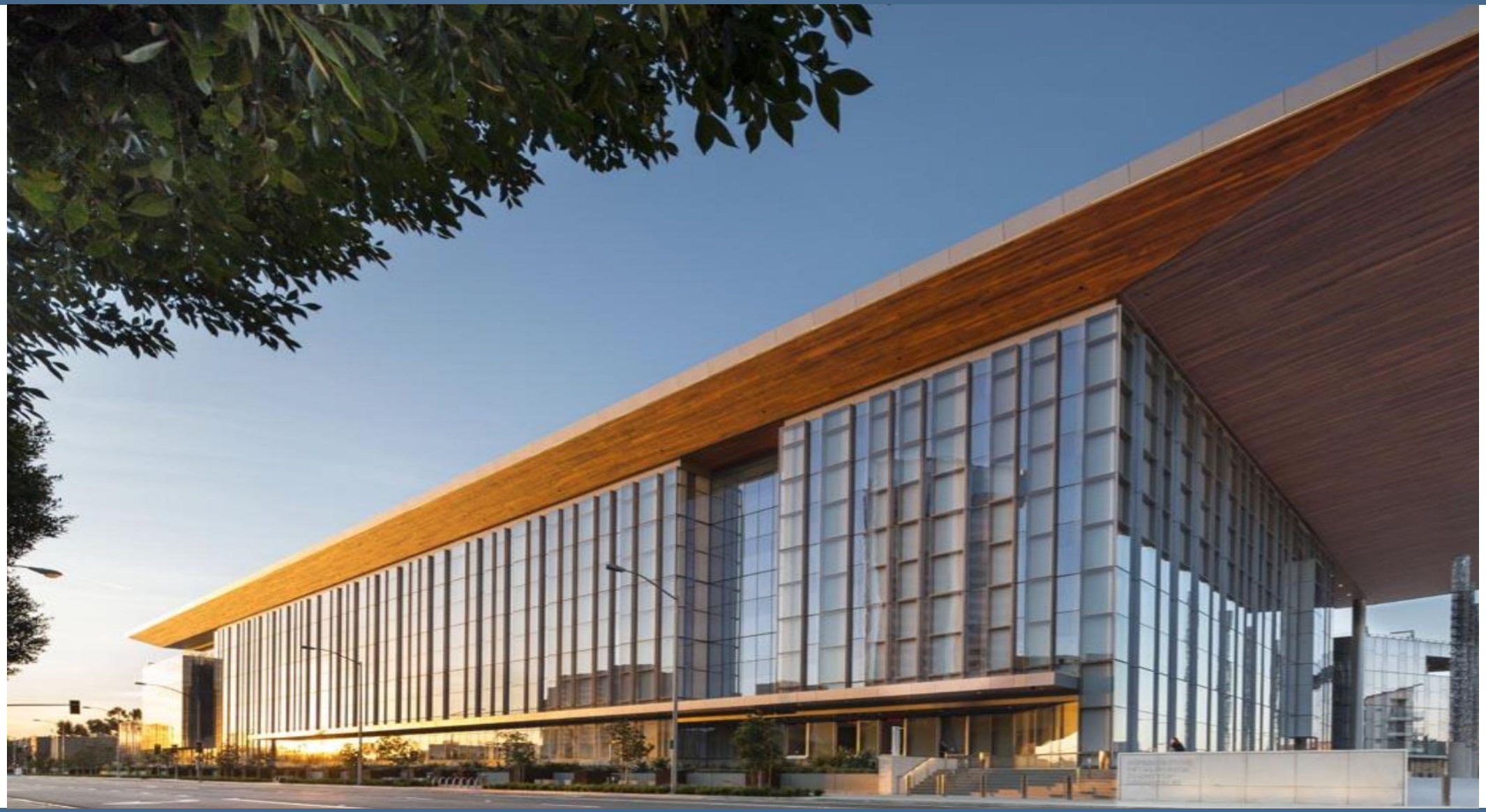
II. **Identify** the opportunities and challenges of the P3 method in project definition, design, construction, and operations.

III. **Document** the benefits of the P3 method for the project sponsor (client).

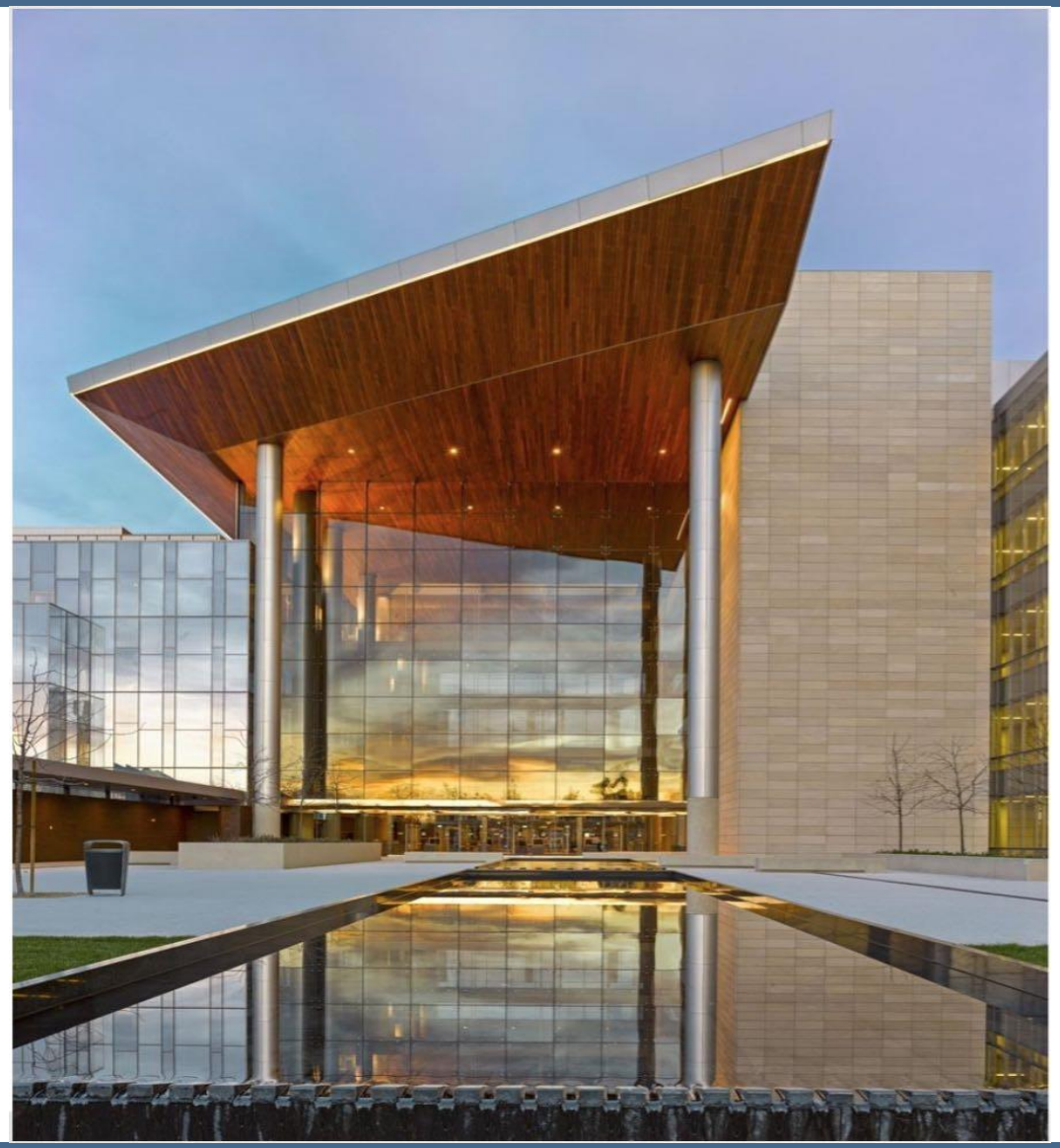
IV. **Develop** a set of conclusions that can be perused by public and private entities.

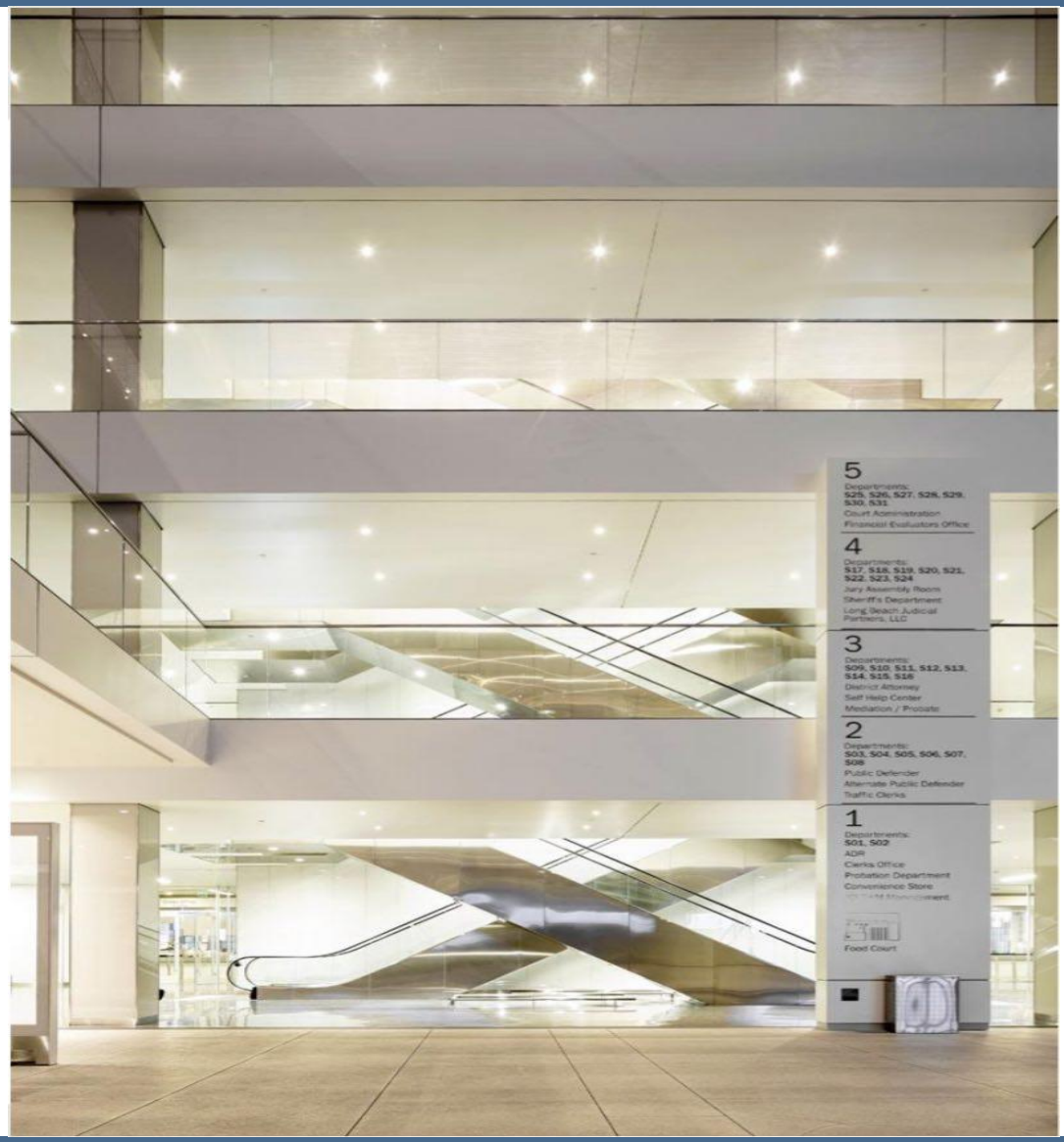
V. **Exemplify** innovative solutions in delivering public infrastructure projects in the US.

The project



The project



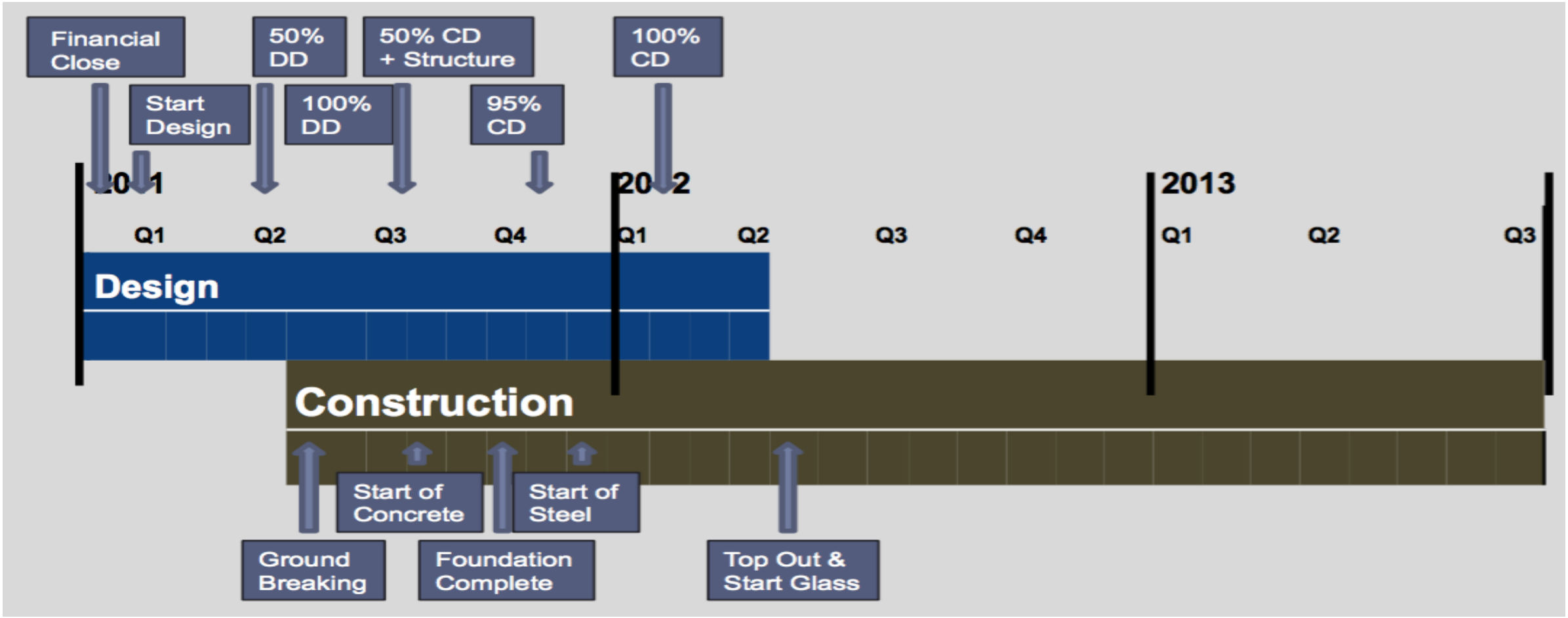


The project

Findings

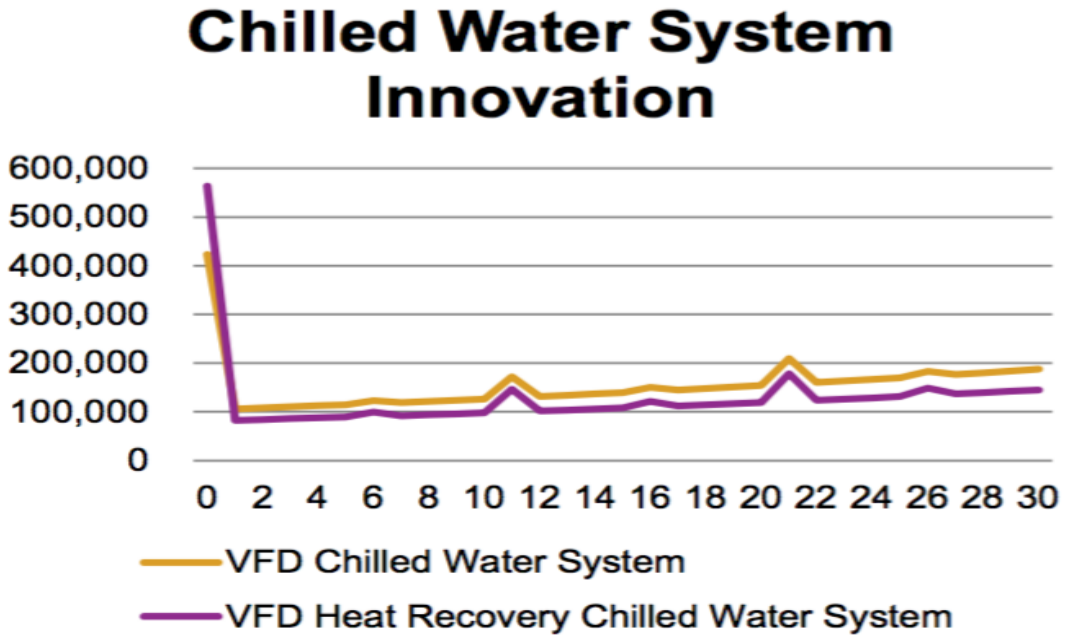
1	Commercial construct incentivizes innovation throughout the process
2	Leverage on expertise of private sector throughout.
3	Shift towards a long view of the project (life cycle vs upfront costs)
4	Sustainability is built in from the start to produce a competitive design
5	Operator participates from the start to guide design decisions
6	Requirement to return the building at a certain FCI ensures performance
7	Enables fast-track construction (completed 2 years faster)
8	Implementation of best-practices to avoid performance-based penalties
9	Collaboration and communication are critical

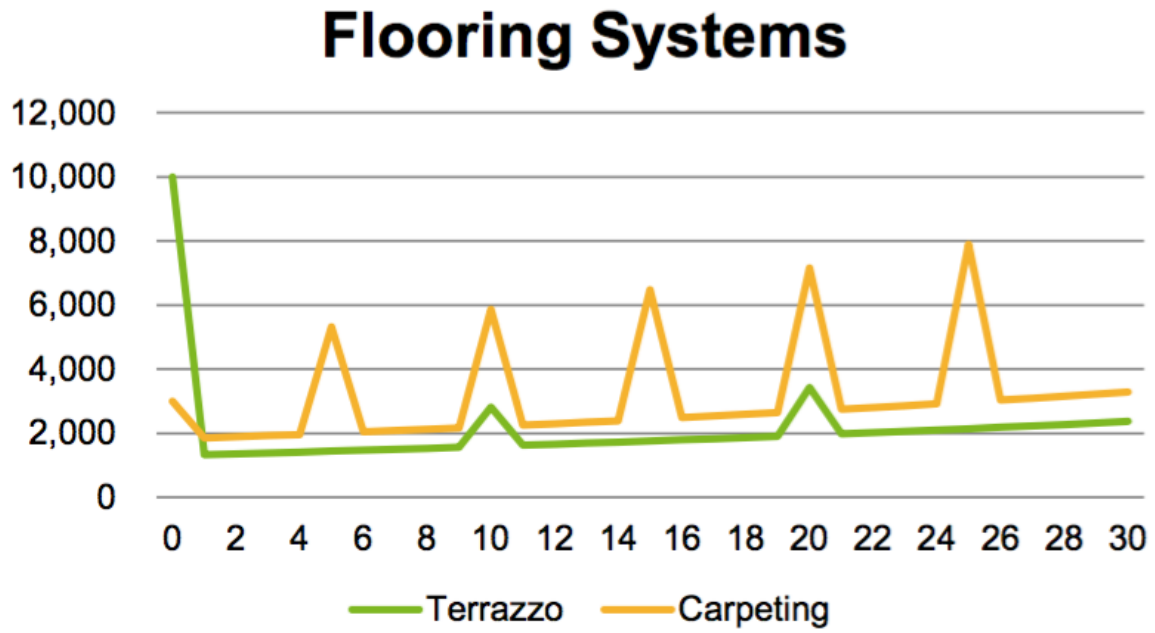
7. Fast-track construction (completed 2 years faster)



6. End-of-life FCI requirement

5. Operator participates in design



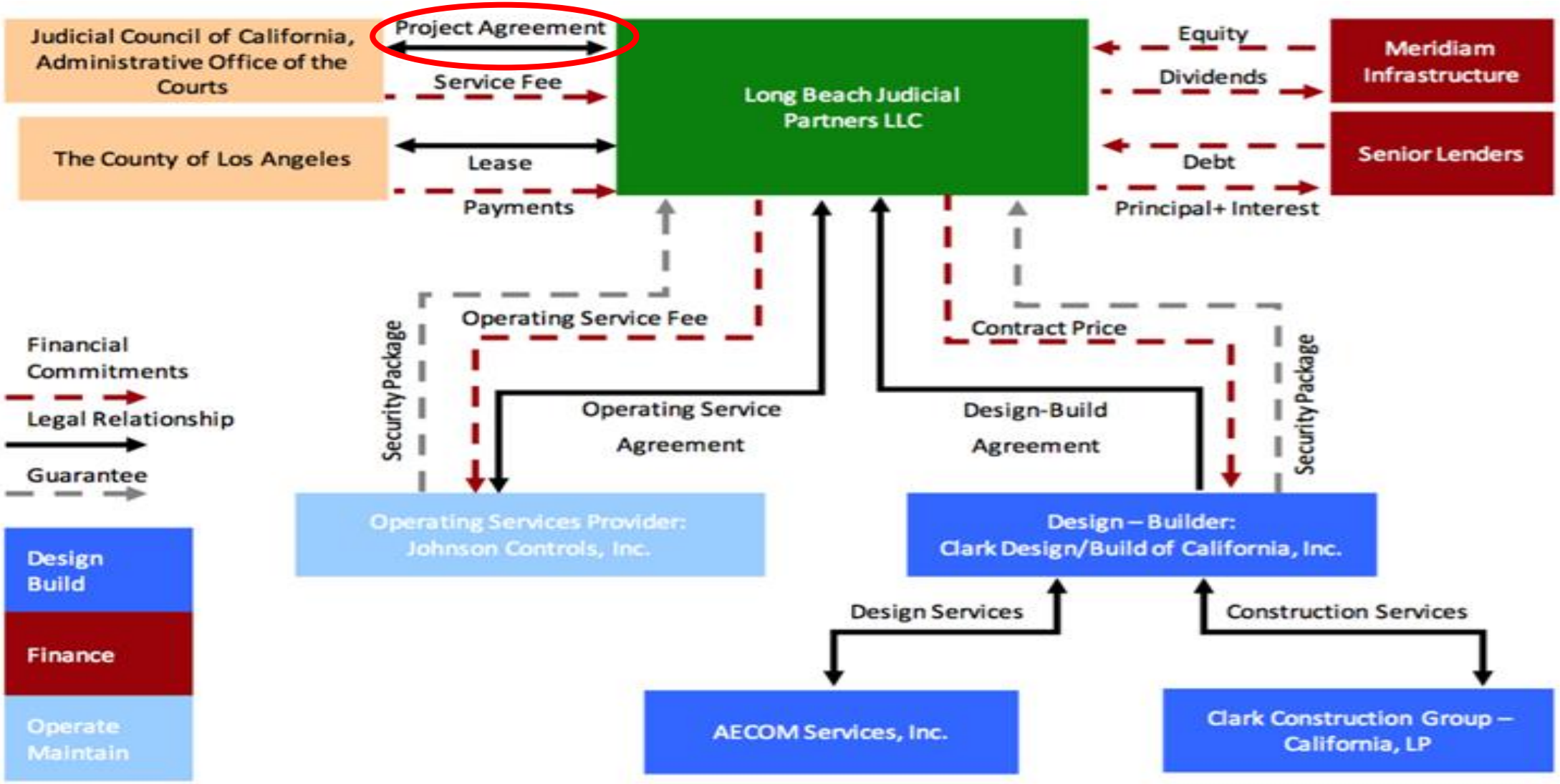


3. Long view of the project

4. Sustainability built-in from the start

1. Commercial construct

2. Private sector expertise



1. Commercial construct

periods unavailable	2	(2 hr period)	
floors affected	4	floors	
Functional Unit	**# of Units / floor**	**Unit Deduction**	**Total Deduction**
Courtrooms	2	$384	$6,144
Holding Cells	7	$96	$5,376
Interview Rooms	2	$96	$1,536
Attorney/Client Room	4	$96	$3,072
Elevator Unavailability Penalty			$5,000
Total			**$ 21,128**

Conclusions

1. **PPP process facilitated sustainability outcomes** not possible with other methods.

2. **Commercial construct is key** and the main driver of improved outcomes.

3. **Provides best value and long term benefits** for government or project sponsors in general.

4. **Considerable challenges** but manageable with a good team.

5. **Collaboration and communication is critical**, within the project team and with the client.

ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE

THANK YOU

Dr. Andreas Georgoulias
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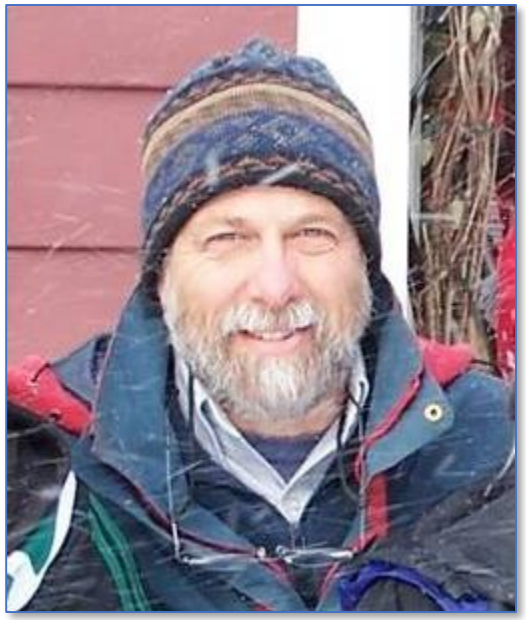
Monitoring Infrastructure Performance

Jennifer Jurado
Chief Resilience Officer
Division Director
Broward County



Peter Murdoch
Regional Science Advisor
USGS

Andreas Georgoulias
Research Director
Zofnass Program for Sustainable Infrastructure

Thank you!

- The ***Climate-Safe Infrastructure*** Webinar Series continues at least through July 2018
- Upcoming webinars:
  - Financing the Future, Part 3 – late June 28
  - Talking Climate Change with Engineers – July 10 or 12
  - Track webinars and progress of CSIWG at: http://resources.ca.gov/climate/climate-safe-infrastructure-working-group/
- Questions: Joey Wall - Joseph.Wall@resources.ca.gov

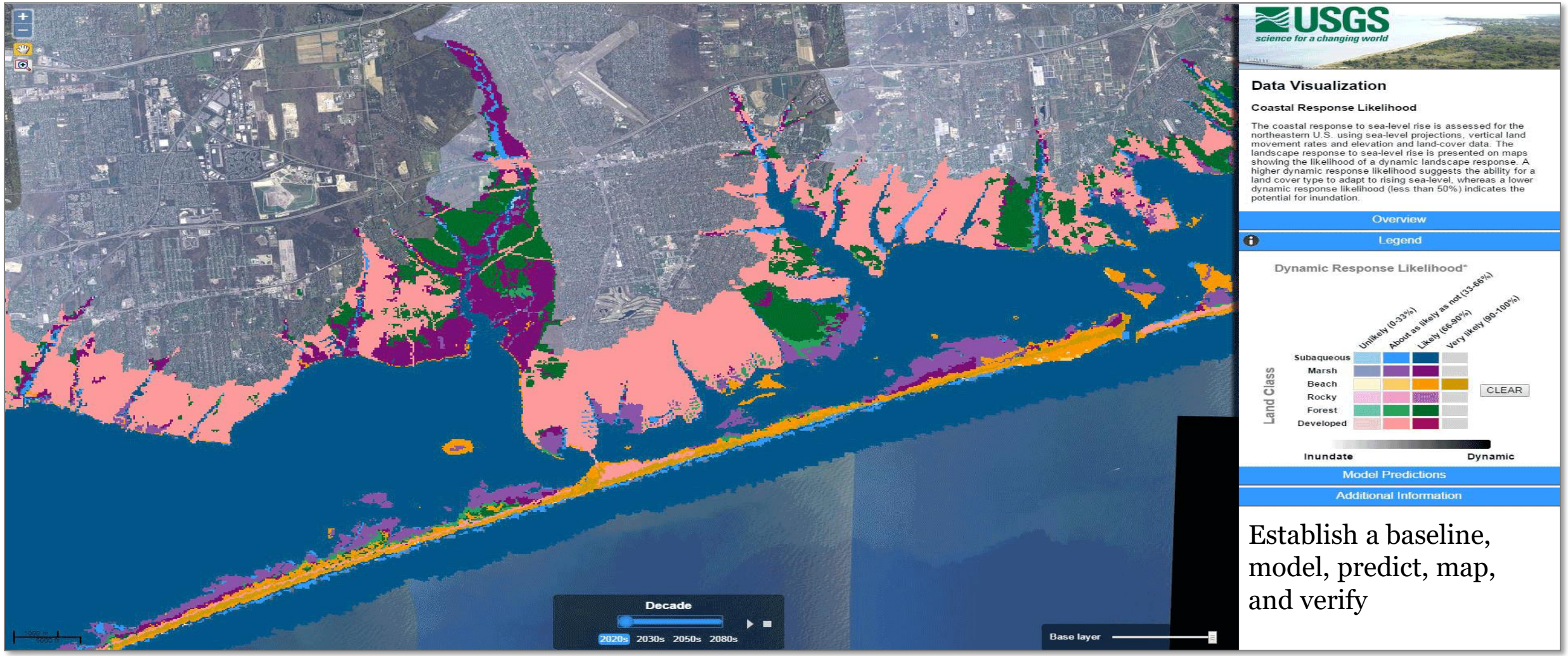
Extra slides

What is success?

1. **Combination of physical (functional) resilience change and a change in societal capacity (fewer negative health or economic effects from disturbance).**
2. **Required standardized performance metrics for project comparisons to define best practice**
3. **Goal: incorporate these performance metrics into decisions (permitting, policy, management)**

The Benefit: Integrated research and monitoring of core metrics creates best practices and reduces long-term mitigation and restoration costs

Incorporate Trend Models: New LIDAR-Based Predictions of Sea Level Rise Vulnerability (Lentz et al, 2016)



Establish a baseline, model, predict, map, and verify

Ecological Monitoring: DOI Core Metrics

Beach and Dune Restoration

- Fish, wildlife population, recruitment, overwintering, stopover weight
- Vegetation cover of dunes, pre and post
- Dune characterization
- Beach width, elevation, volume, shoreline position
- Post-storm volume of sand in active shoreface*

Living Shorelines

- Oyster length/frequency
- Oyster coverage & population
- Vegetation cover
- Water temperature, salinity
- Vertical accretion rates
- Shoreline position